



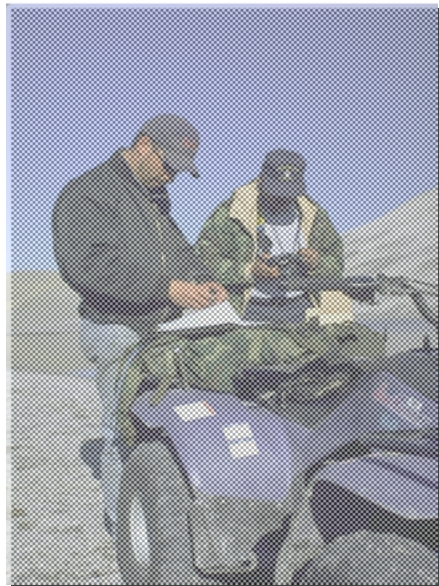
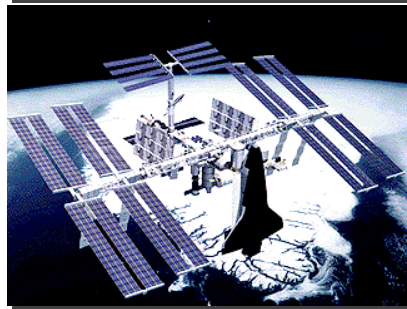
# **Toward Rapidly Reconfigurable Human Simulation Architectures**

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# Human Simulation at NASA



- Designing and evaluating aircraft/spacecraft cockpits
- Planning crewed missions
- Artificial participants in training simulations
- Designing autonomous robots



# Challenge

Create human modeling architectures that can be **rapidly reconfigured** to simulate human behavior in new applications

Several NASA programs are investing to support this goal:

- Virtual Airspace Modeling (VAM)
- Intelligent Systems (IS-HCC)
- Aviation Safety (AvSaf-SWAP)



# Aviation Safety Program System-Wide Accident Prevention

Goal: facilitate creation of sharable/reusable human modeling components useful for evaluating new aviation technologies (e.g. visual perception)

Funds diverse approaches; emphasizes cooperation

- Industry (D-OMAR, FAIT)
- Academia (ACT-R)
- NASA (Brahms, AirMIDAS, Apex)

To learn more, contact Tina Beard ([tlbeard@arc.nasa.gov](mailto:tlbeard@arc.nasa.gov))



# Apex PROJECTS



Human-like agents  
behavior representation



Interface evaluation  
building blocks

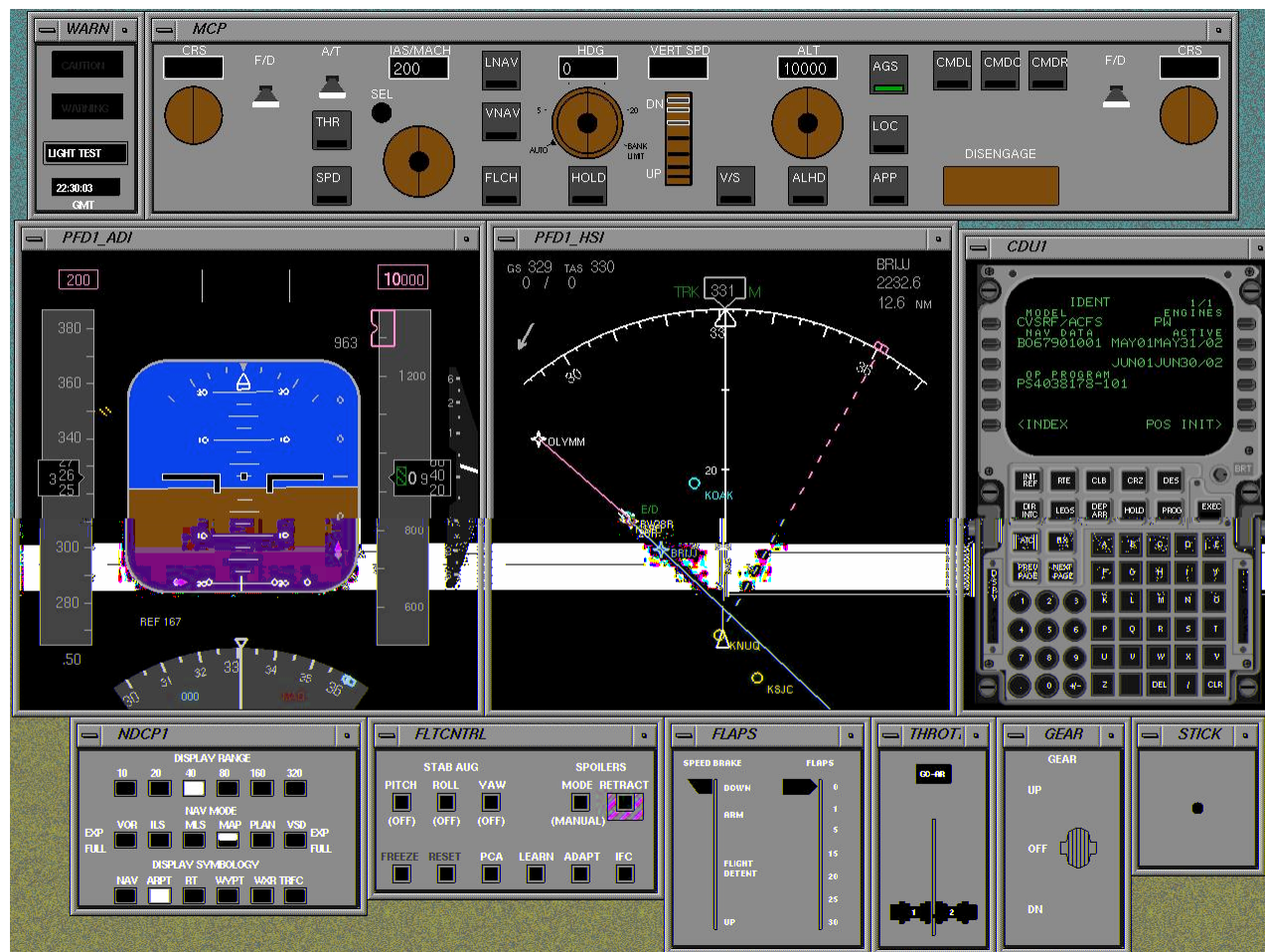


Autonomous robots  
interoperability





# Rapid reconfigurability goal #1: Reduce time/expertise needed to represent behavior





# Representing simple behaviors should be easy

- concurrency
- reactivity
- hierarchy

```
(procedure
  (index (hold-altitude using mcp))
  (step s1 (clear right-hand))
  (step s2 (find-location alt-hold-button => ?loc)
    (waitfor ?s1))
  (step s3 (press-button ?loc right-hand)
    (waitfor ?s2))
  (step end (terminate)
    (waitfor ?s3)))
```



# Representing more complex behavior should also be easy

Idioms for concurrency control

## Converge

```
(procedure
  (index (do-it))
  (step s1 (do-A))
  (step s2 (do-B))
  (step s3 (do-C))
  (waitfor ?s1 ?s2)
  (step s4 (terminate)
    (waitfor ?s3)))
```

## Race

```
(procedure
  (index (do-it))
  (step s1 (do-A))
  (step s2 (do-B))
  (step s3 (do-C))
  (waitfor ?s1)
  (waitfor ?s2))
(step s4 (terminate)
  (waitfor ?s3)))
```

## Synchronize

```
(procedure
  (index (do-it))
  (step s1 (do-A))
  (step s2 (do-B))
  (waitfor (started ?s1)))
(step s3 (terminate)
  (waitfor ?s1 ?s2)))
```





# Representation of really sophisticated behavior should be well-supported

Example: High-level multitasking behavior

- Delay answering phone until finished typing sentence
- Pull over to side of road before studying map
- Drive back onto road (but don't drive to start point)
- Do something useful when stopped at a red light
- ...



# Support for high-level multitasking

```
(procedure
  (index (hold-altitude using mcp))
  (profile right-hand)
  (step s1 (clear right-hand))
  (step s2 (find-loc alt-hold-button => ?loc))
  (step s3 (press-button ?loc right-hand)
    (waitfor (empty right-hand)
      (location alt-hold-button ?loc)))
  (step end (terminate)
    (waitfor (illuminated alt-hold-button))
  (step aux1 (restart ?self)
    (waitfor (resumed ?self))))
```

- language
- architecture
- methodology

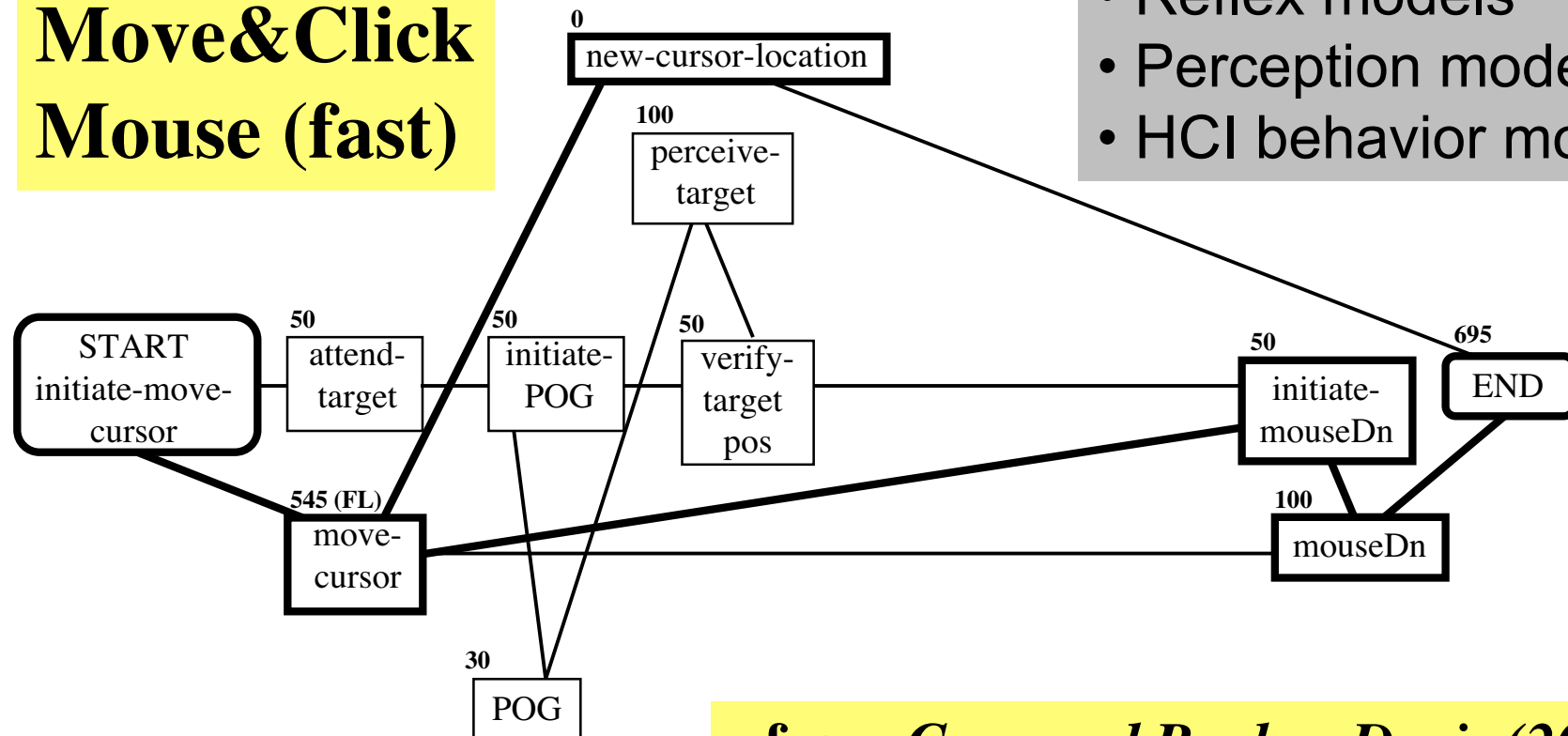


## Rapid reconfigurability goal #2: Provide reusable “building-blocks” for new apps

### Move&Click Mouse (fast)

#### Examples

- Reflex models
- Perception models
- HCI behavior models

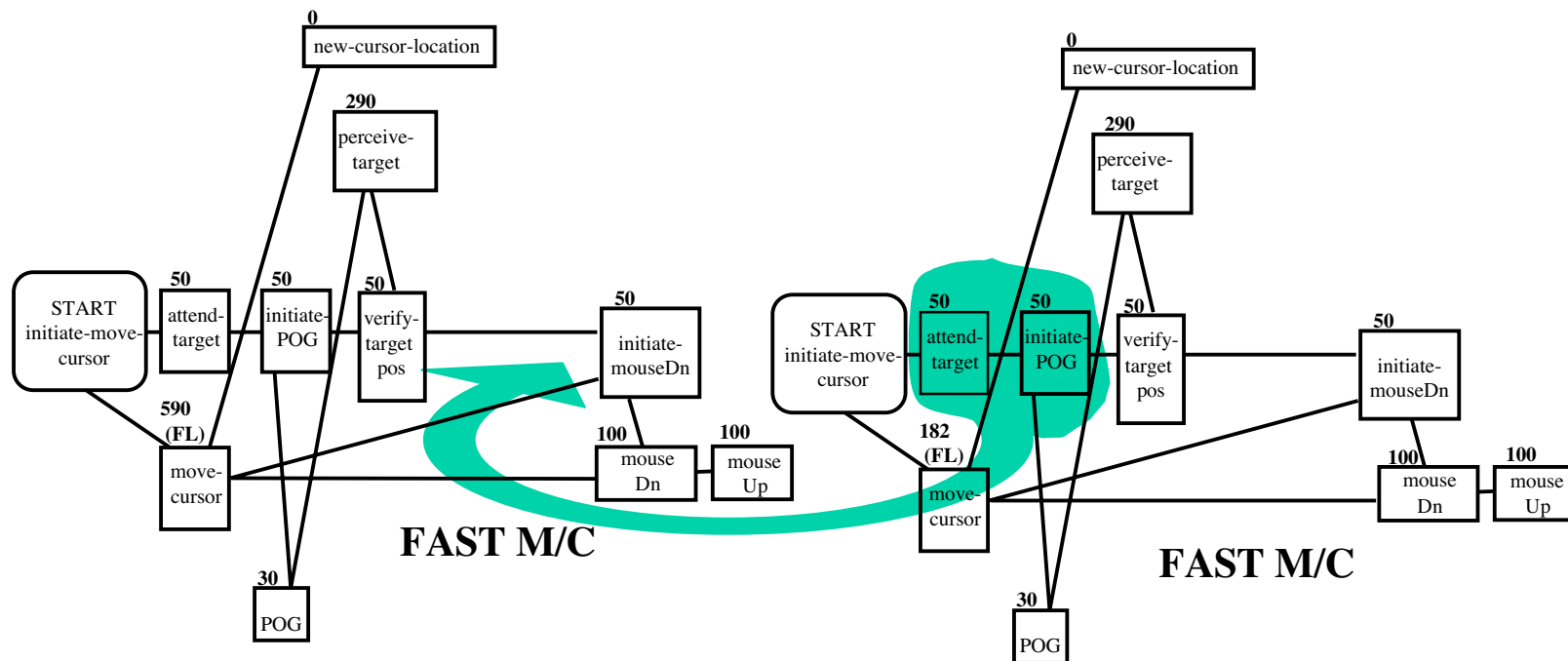


- from *Gray and Boehm-Davis (2000)*



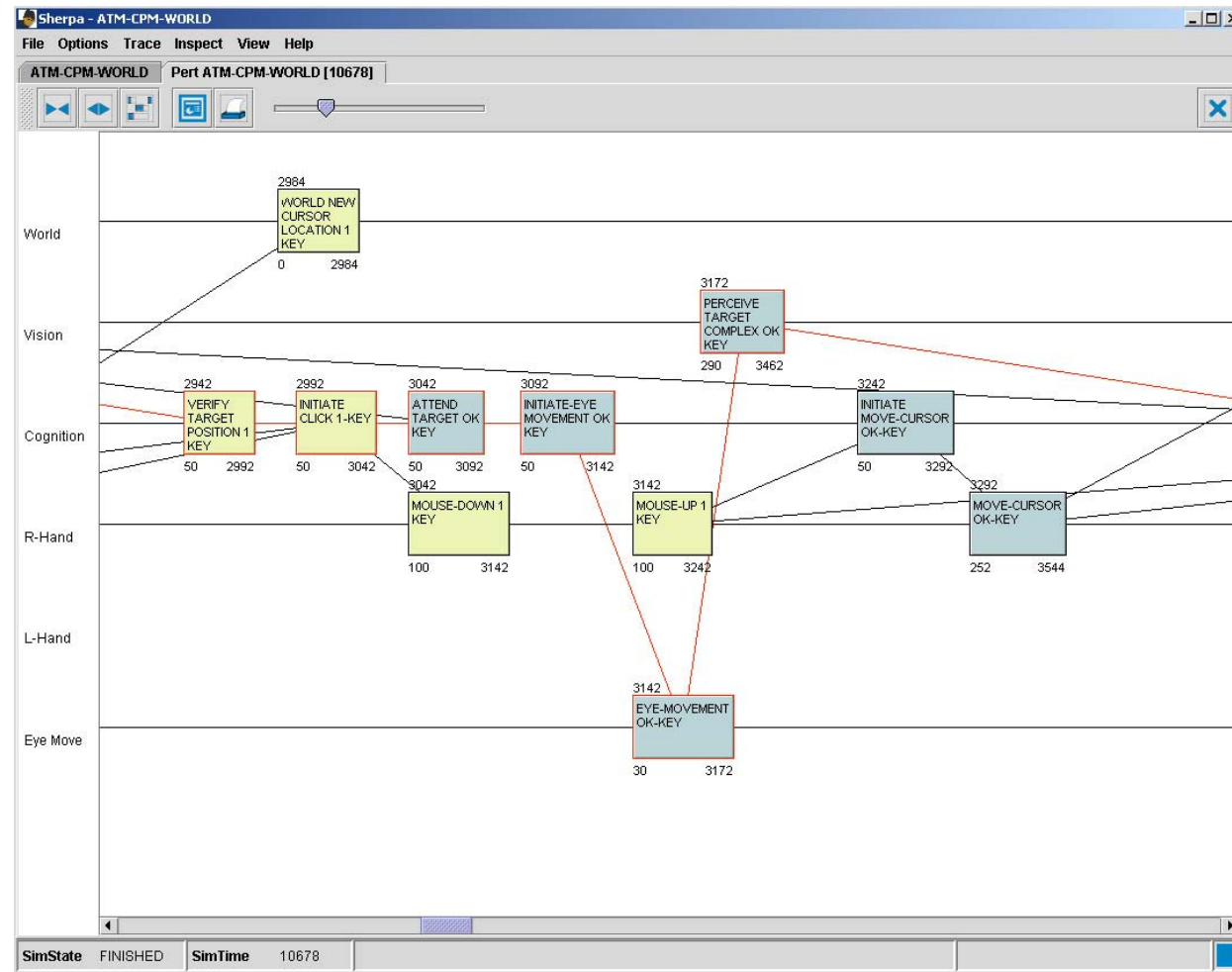
# CPM-templates as building blocks

- Apex interleaving tasks automatically
- Interleaving improves accuracy of time predictions





# Automatic Identification of Critical Path





## Rapid reconfigurability goal #3

### Easy to interoperate with other systems







# Summary

Human simulation is becoming increasingly important for NASA missions. Rapidly reconfigurable modeling architectures will help meet future needs.

Apex addresses the goal of rapid reconfigurability with:

1. A high-level behavior representation language
2. Building blocks that incorporate human performance data
3. Software that facilitates interoperability

Apex software is available at:

<ftp://eos.arc.nasa.gov/outgoing/apex/apex>

